

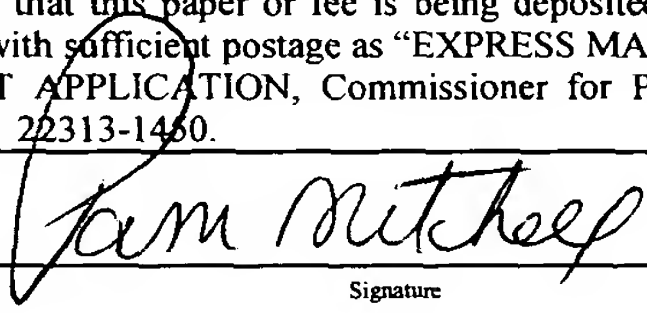
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for

**POSITIONING A FIRST SURFACE IN A PRE-DETERMINED
POSITION RELATIVE TO A SECOND SURFACE**

BY

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POSITIONING A FIRST SURFACE IN A PRE-DETERMINED POSITION RELATIVE TO A SECOND SURFACE

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BACKGROUND OF THE INVENTION

1. FIELD OF THE INVENTION

This invention relates generally to positioning a surface, and, more particularly, to positioning a first surface in a pre-determined manner relative to the positioning of a second surface.

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2. DESCRIPTION OF THE RELATED ART

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Innovations in the computer display area have resulted in dramatic improvements of products that are used for displaying computer input and output. Monitors attached to computers have progressively become more space efficient along with being brighter and having higher resolution. Portable computers have become even more practical due to the advancements made in the field of computer displays. Innovations in this area have produced very thin displays that utilize small amounts of real estate while providing a quality display of computer graphics. For example, thin displays, such as those that are based upon liquid crystal display (LCD) technology, have been utilized.

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One of the issues relating to thin displays, such as LCD screens, relates to the brightness and the quality of sections of the LCD screens. For example, much work has been dedicated to improving the brightness of LCD displays. Also, a large amount of effort has been dedicated to providing displays that provide more accurate colors and brightness when viewed at particular angles.

One of the problems associated with the manufacture of LCD displays include manufacturing a number of LCD displays, such as LCD monitors, that have fairly consistent displays in terms of sharpness, contrast, color, and/or other features when viewed at various angles. When manufacturing LCD displays, a number of tests are performed on the various portions of the screen of the display for quality control. Testing instruments are generally oriented at various angles, such as in a perpendicular orientation, and testing is then performed on the LCD screens as part of the manufacturing and testing processes. For example, testing includes measuring various colors on LCD screens according to predetermined standards, such as the ISO 13406 Standard. Often, a perpendicular orientation of the test instrument to the screen of the LCD monitor is used.

The accuracy of the angle in relation to the test instrument and the LCD screen is important to the accuracy of the test performed on the display screen. One of the problems associated with the current methodology is that the test operator generally positions an instrument to the LCD screen utilizing approximations, which may cause delay and inaccurate test results. Additionally, a test angle used to analyze one LCD monitor may vary from the angle used to analyze another LCD monitor, thereby resulting in inconsistent test results of a batch of LCD monitors. Dedicating more time and resources to insure the accuracy of the angle between the test instrument and the LCD screen may cause inefficiencies (*e.g.*, inaccurate testing, repeating screen adjustments, etc.) during the manufacturing and testing of computer displays, such as LCD monitors.

The present invention is directed to overcoming, or at least reducing, one or more of the problems set forth above.

SUMMARY OF THE INVENTION

In one aspect of the present invention, a method is provided for positioning a first apparatus in relation to a second apparatus. An optical signal from a first apparatus is sent to
5 a second apparatus. A reflection of the optical signal from the second apparatus is received. A position of one of the apparatuses relative to the other apparatus is adjusted based upon the reflection.

In another aspect of the present invention, a system is provided for positioning a first
10 apparatus in relation to a second apparatus. The system of the present invention includes an optical source affixed to the first apparatus. The optical source is provided for directing an incident light to the second apparatus. The system of the present invention also includes a light receiving unit to receive reflective light reflected from the second apparatus. The reflective light is used to adjust the positioning of the first apparatus in relation to the second
15 apparatus.

In another aspect of the present invention, an apparatus is provided for positioning a first device in relation to a second device. The apparatus of the present invention includes an optical source affixed upon the first device. The optical source includes a screen. The optical
20 source is capable of providing an incident light that is directed towards the second device, from which a reflected light is received upon the screen. The apparatus is also capable of adjusting the relative positioning between the first and second devices based upon an angle of the reflected light.

In yet another aspect of the present invention, a system is provided for positioning a testing unit in relation to a computer display. The system of the present invention includes a testing unit for performing a test upon the computer display or a television screen. The system of the present invention also includes an optical source affixed to the testing unit. The optical source is provided for directing an incident light to the computer display. The system of the present invention also includes a light receiving unit for receiving reflective light reflected from the computer display. The location of the light receiving unit upon which the reflective light is received is used to adjust the positioning of the testing unit in relation to the computer display.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention may be understood by reference to the following description taken in conjunction with the accompanying drawings, in which like reference numerals identify like elements, and in which:

Figure 1 provides a depiction of an implementation of one embodiment of the present invention;

Figure 2 provides a depiction that illustrates the angles of the incident light and the reflected light, in accordance with an illustrative embodiment of the present invention;

Figure 3 provides a depiction of an implementation of one embodiment of the present invention in the context of testing a computer display device, in accordance with an illustrative embodiment of the present invention;

Figure 4 provides an illustration of an alternative implementation front surface of an alignment object of Figure 1, in accordance with an illustrative embodiment of the present invention;

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Figure 5 provides an illustration of an implementation of an embodiment of the present invention using the sensors of Figure 4, in accordance with an illustrative embodiment of the present invention; and

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Figure 6 provides a depiction of an implementation of one embodiment of the present invention using a feedback control system, in accordance with an illustrative embodiment of the present invention.

While the invention is susceptible to various modifications and alternative forms, specific embodiments thereof have been shown by way of example in the drawings and are herein described in detail. It should be understood, however, that the description herein of specific embodiments is not intended to limit the invention to the particular forms disclosed, but on the contrary, the intention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the invention as defined by the appended claims.

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DETAILED DESCRIPTION OF SPECIFIC EMBODIMENTS

Illustrative embodiments of the invention are described below. In the interest of clarity, not all features of an actual implementation are described in this specification. It will of course be appreciated that in the development of any such actual embodiment, numerous

implementation-specific decisions must be made to achieve the developers' specific goals, such as compliance with system-related and business-related constraints, which will vary from one implementation to another. Moreover, it will be appreciated that such a development effort might be complex and time-consuming, but would nevertheless be a
5 routine undertaking for those of ordinary skill in the art having the benefit of this disclosure.

Embodiments of the present invention provide for a method and an apparatus for positioning a first device in relation to a second device. For example, the first device may be a measuring instrument or a test instrument that is aligned or positioned in relation to a second device, such as the LCD screen of a computer display and/or a television screen.
10 Therefore, the measuring instrument can be aligned more accurately, such that consistent testing of various LCD screens may be performed, thereby increasing the efficiency of testing of computer displays.

Embodiments of the present invention provide for an optical source that is affixed to a test instrument wherein a light source (*e.g.*, a laser) is pointed towards a subject, such as the
15 LCD screen, which may contain a reflective material (*e.g.*, a mirror) affixed upon its surface. The light is then reflected back to a screen that may be affixed to the test instrument or the optical source. Therefore, the orientation of the reflected light upon the screen may be used to more accurately align or position the measuring instrument in relation to the LCD screen.

Embodiments of the present invention may be used for various other applications
20 where an alignment of one object is performed in relation to another object. For example, during construction of structures, such as bridges, buildings, *etc.*, one object may be aligned with a second object, such as a wall, a support column, or the like. The angular relationship

between the two objects may be more accurately deciphered utilizing the light source and the reflected light positioning on a screen provided by embodiments of the present invention. Although for clarity of the description, portions of the invention are described in terms of the embodiment of a test source and a LCD screen, the embodiments of the present invention
5 may be used for a variety of applications and remain within the scope and the spirit of the present invention.

Turning now to Figure 1, a depiction of an implementation of one embodiment of the present invention is illustrated. Figure 1 illustrates an alignment object 110 that is to be aligned with an optical source 130. The optical source 130 may be affixed to a second object
10 135, such as a testing device, that is positioned relative to the alignment object. In one embodiment, the alignment object 110 may be an LCD screen, which may be tested by the testing device. In alternative embodiments, the alignment object 110 may be a wall, a support column, or any other object upon which alignment with the second object 135 is desired. The alignment object 110 comprises a front surface 120, which may be positioned
15 relative to the second object 135. A reflective material 170 may be affixed upon the front surface 120 of the alignment object 110. The affixation of the reflective material 170 may be performed in a variety of manners, such as magnetic means, adhesive means, or other means known to those skilled in the art having benefit of the present invention.

The optical source 130 is capable of providing an incident light 140 that is directed
20 towards the front surface 120 of the alignment object 110. The incident light 140 may be a light beam, a laser beam (*e.g.*, such as a diode laser beam or any other type of laser), or any other type of light source. The optical source 130 provides the incident light 140, which is

directed towards the reflective material 170 that is placed upon the alignment object 110. The reflective material 170 may be a mirror or other type of reflective material that may be utilized by those skilled in the art having benefit of the present disclosure.

The incident light 140 is reflected by the reflective material 170 to provide a reflected
5 light 150. The reflected light 150 may then be received by a screen 160. The screen 160 may be of a variety of materials that are capable of absorbing a portion of the reflected light 150. The screen 160 may be coupled to the optical source 130 or may be positioned at a known relative position from the optical source 130. The screen 160 may be used to align the optical source 130 with the front surface 120 of the alignment object 110. Based upon the position
10 of the reflected light 150 on the screen 160, the optical source 130 may be adjusted such that the alignment between the optical source 130 and the alignment object 110 is positioned at a desired angle in relation to the second object 135. The screen 160 may comprise various types of markings that may be used to adjust the position of the optical source 130 until the reflected light 150 is directed towards a desired marking on the screen 160, which allows one
15 to align the optical source 130 and the second object 135 at a desired angle in relation to the alignment object 110. The adjustments of the positioning of the optical source 130 in relation to the alignment object 110 may be performed using a manual adjustment process by an operator, or performed automatically using a feedback control system, which may employ one of a variety of control systems, such as a Servo Control System known to those skilled in
20 the art (an example of a servo control system is the Cobra 600 C-60 ® servo control system, publicly offered by Adept Technology, Inc., of Livermore, CA, U.S.A.)

Turning now to Figure 2, a depiction illustrating the angles of the incident light 140 and the reflected light 150 is provided. Figure 2 illustrates a reference line 210 that may be utilized to determine the positioning of the optical source 130 and the second object 135, in relation to the alignment object 110. A reference line 210 may be based upon a reference in
 5 relation to the front surface 120 of the alignment object 110. Initially, the optical source 130 may be positioned in relation to the reference line 210, and using this reference, an incident light 140 is directed towards the reflective material 170 on the front surface 120 of the alignment object 110. Therefore, the incident light 140 may be at an incident angle 220 (ϕ_1) in relation to the reference line 210. If a perpendicular orientation between the second object
 10 135 and the alignment object 110 is desired, the initial incident angle 220 may be approximately zero. A reflective angle 230 (ϕ_2) may be defined as the angle between the incident light 140 and the reflected light 150, which is received by the screen 160. Various markings written on the screen 160 may be utilized to determine the incident angle 220 based upon the reflective angle 230. In other words, the reflected light 150 and the reflective angle
 15 230 may be used to position the optical source 130 to a desired incident angle 220.

Turning now to Figure 3, a depiction of one embodiment of the present invention is illustrated utilizing an LCD monitor. Figure 3 illustrates a computer display device 310 (*e.g.*, monitor 310), such as an LCD monitor, whose screen 320 may be tested using a testing device 350. In one embodiment, the monitor 310 may be a television screen. The testing
 20 device 350 may be a measurement device, such as photometers, radiometers, and the like. The monitor 310 may be the monitor 310 of a desktop computer or a portable computer and other types of computer displays, such as the screen on the iMac[®] offered by Apple, Inc. The optical source 130 is affixed to the testing device 350. The optical source 130 may be affixed

to the testing device 350 in a variety of manners, such as adhesive attachments, mechanical attachments, or any other types of attachments. Additionally, the screen 160 may be positioned on the optical source 130. For example, the screen 160 may be positioned in front of the optical source 130 such that reflected light 150 received by the screen 160 is very close
5 to the optical source 130.

The alignment of the testing device 350 in relation to the monitor 310 may be performed in an efficient and accurate manner using the optical source and the reflected light 150 received by the screen 160. The optical source 130 provides the incident light 140, which is directed towards the reflective material 170 that is affixed on the screen 320 of the
10 monitor 310. The reflected light 150 from the reflective material 170 is then received by the screen 160. Based upon the position of the reflected light 150 on the screen 160, the desired incident angle 230 may be achieved. For example, if the testing device 350 is to be substantially perpendicular to the LCD screen 320 of the monitor 310, the reflective angle 230 may be arranged such that it is substantially zero. Utilizing this method, consistent
15 measurement of a plurality of monitors 310 may be performed with a predictable margin of error of the reflective angle 230. Therefore, using embodiments of the present invention, consistent evaluation of various LCD screens 320 of various monitors 310 may be performed.

Turning now to Figure 4, an alternative embodiment of the implementation of the surface of the alignment object 110 is illustrated. In one embodiment, the front surface 120
20 of the alignment object 110 may comprise a plurality of sensors 410. These sensors 410 may be photo-sensors or other types of sensors 410 that are capable of detecting the incident light 140. For example, the sensors 410 may comprise an opto-coupler circuit wherein a signal is

asserted to logic high or to logic low, based upon light detected by the opto-coupler circuit in the sensors 410. The sensors 410 may be positioned in a variety of manners on the front surface 120 of the alignment object 110. A plurality of sensors 410, such as an array of sensors 410, may be placed on the front surface 120. Therefore, the incident light 140 from the optical source 130 may be directed towards one of a number of sensors 410 on the front surface 120 of the alignment object 110, wherein the orientation of the optical source 130, or any other object affixed to the optical source 130, may be efficiently determined.

Turning now to Figure 5, an implementation of the embodiment utilizing the sensors 410 of Figure 4 is illustrated. Figure 5 illustrates an alignment object 110 that comprises a plurality of sensors 410 on the front surface 120 of the alignment object 110. The second object 135, which is to be aligned in relation to the alignment object 110, is affixed to the optical source 130. The optical source 130 provides an incident light 140 that is at an incident angle 220 in relation to the reference line 210. Figure 5 illustrates two methods of determining the position of the second object 135 in relation to the alignment object 110. In one embodiment, the sensor 410 that receives the incident light 140 may provide either a reflective light 150 or another light generated by the sensor 410 towards the screen 160. Therefore, this reflected or secondary light 150 generated by the sensor 410 may be at a reflected angle 230, which then can be adjusted by moving the second object 135 along with the optical source 130 to achieve a desired orientation between the second object 135 and the alignment object 110.

In an alternative embodiment, the sensors 410 that receive the incident light 140 may activate a signal that is received by the sensor controller 520. Based upon which sensor 410

asserts the received signal that indicates that an incident light 140 has been received, the sensor controller 520 is capable of determining the incident angle 220. Based upon information from the sensor controller 520, the position of the second object 135, along with the optical source 130, may be adjusted such that a different incident angle 220 is achieved and a different sensor 410 on the front surface 120 of the alignment object 110 is activated, the signal from which is detected by the sensor controller 520. Utilizing a progressive, iterative-type process, a desired orientation of the second object 135 to the alignment object 110 may be performed. The sensors 410 may be placed on a variety of types of alignment objects 110, such as on computer monitors, construction walls, support columns, and the like.

Turning now to Figure 6, an implementation of the present invention utilizing a feedback control process is illustrated. Figure 6 also illustrates an optical source 130 that is affixed to the second object 135. Figure 6 also illustrates a feedback control unit 610, which is capable of performing feedback control to align the second object 135 with the alignment object 110 to a desired orientation. The feedback control unit 610 may comprise a computer system, a controller, a microcontroller, a processor, or other electronic circuitry (hardware, software, firmware, or a combination of two or more) that can detect and generate signals to control the alignment of the second object 135 with the alignment object 110.

The feedback control unit 610 is capable of controlling the operation of an alignment unit 620. The alignment unit 620 may comprise a control system that may be used to position the alignment object 110. The alignment unit 620 may comprise a motor, such as a servo motor that may be utilized to operate a positioning arm 630, which may be used to control the alignment of the alignment object 110. An example of a servo motor is a 750 Watts servo

motor, publicly offered by Adept Technology, Inc., of Livermore, CA, U.S.A. In an alternative embodiment, the alignment unit 620 may be used to control the positioning of the second object 135. The feedback control unit 610 may send control signals to the alignment unit 620 via a line 635.

5 The optical source 130 provides an incident light 140 that is at an incident angle 220 in relation to the reference line 210. The incident light 140 is then reflected by the reflective material 170 to produce a reflected light 150, which is at a reflective angle 230 in relation to the incident light 140. The reflected light 150 is then received by a light receiving unit 660. The light reflecting unit 660 may comprise a screen 160. The light reflecting unit 660 may
10 also comprise a device that contains electronic circuitry, such as an opto-coupler and related electrical circuitry to provide a signal indicative of the position on the screen 160 upon which the reflected light 150 has been received. This signal may be sent to the feedback control unit 610 on a line 625.

 The feedback control unit 610 is capable of calculating the incident angle 220 and/or
15 the reflective angle 230 based upon the signal received on the line 625 from the light reflecting unit 660, which provides information as to which position on the screen 160 received the reflected light 150. The feedback control unit 610, in response to receiving the signal indicative of the position of the reflective light 150, determines the position of the optical source 130 and the second object 135. Based upon the angle 220, 230, the feedback
20 control unit 610 may calculate an adjustment that is to be performed on the alignment object 110. Accordingly, this calculation may be used to provide a control signal on the line 635 to the alignment unit 620 to change the relative orientation of the alignment of the alignment

object 110. The alignment unit 620 then utilizes the positioning arm 630 to position the alignment object 110. Therefore, a feedback loop may be created until the desired relative orientation of the second object 135 to the alignment object 110 is achieved.

Utilizing embodiments of the present invention, alignment of multiple objects may be achieved. Therefore, alignment of a tester that tests LCD screens may be aligned consistently on a plurality of LCD screens or television screens to achieve consistent and accurate test results. Utilizing embodiments of the present invention, feedback systems may be used to automatically align multiple objects. Additionally, relative positioning/alignment of larger scale objects, such as construction walls, bridge structures, support columns, and other structures may be analyzed using embodiments of the present invention. Embodiments of the present invention may be utilized in a variety of manufacturing, construction and other types of arenas where alignment of objects is desired.

The particular embodiments disclosed above are illustrative only, as the invention may be modified and practiced in different but equivalent manners apparent to those skilled in the art having the benefit of the teachings herein. Furthermore, no limitations are intended to the details of construction or design herein shown, other than as described in the claims below. It is therefore evident that the particular embodiments disclosed above may be altered or modified and all such variations are considered within the scope and spirit of the invention. Accordingly, the protection sought herein is as set forth in the claims below.